that creates a tilted mark is the addition of a liquid crystal panel that blocks approximately two thirds of one half of the clear aperture of the optical unit focusing the recording beam. In Fig. 11 the track is drawn from a tangential view (track going into the page). The two partially overlapping ellipses indicate the two orientations of servo marks that are tilted relative to this track. If the reading spot 1110 drifts along one of two diagonal directions, along the orientation of the marks, then the signal from one servo marks sequence become weaker much faster than the signal from the other servo marks sequence. The information is not complete, as it does not indicate in which direction along the mark was the relative movement of the spot. The missing information is added by either adding servo marks that have other deformations or by combining these methods with other tracking methods, such as those of the first family of the second approach for achieving the tracking and formatting. An embodiment of tracking with complete information is illustrated in Fig. 10, where an additional pair of servo marks is used (1030, 1040), that are tilted in the tangential direction. These marks enable derivation of an error signal in the axial direction, substantially having every servo mark play the role of two axial i.e. non-tilted servo marks of the first family of the second approach to formatting and tracking, thus completing the information. The use of the tangentially tilted marks has the benefit of one simple scheme for all servo marks but requires more accurate timing of the sampling of the tangentially tilted mark to ensure that comparison is indeed between the first part of the mark that is below (or above) the track and the second part that is on the other side. Methods for creating tilted beam profiles are discussed in the detailed description of the invention and include partial, asymmetrical, obscuration of the objective or the creation of aberrations e.g. comma aberrations by tilting one of the optical elements.

It will be understood that the preferred implementations of the second approach described in the detailed description are also non-limiting and the sampled servo signaling may or may not have dedicated track intervals. If the sampled servo has dedicated intervals, these intervals can be of constant linear length, of constant angular length or even of varying lengths. A continuous data sequence may be recorded using continuous servo information from adjacent servo tracks in the radial and axial directions. The servo signaling marks can additionally be encoded by varying the location or density of the marks, either by varying the location along the track or by

are circular in nature. The nature of the formatting of the media allows the extraction both tracking information and additional track data such as sector number and zone. Said servo signals are recorded in a multi-burst pattern that allows the extraction of fractional radial track error signal and the calibrated and controlled fractional track following.

US Patent No. 6,091,697 (Le Carvennec, *et al.*) corresponding to WO 97/23872 assigned to Thomson CSF and entitled "*Optical recording medium having a plurality of recording layers*" discloses optical information recording/reading medium including at least one transparent layer for recording or reading information in various strata distributed through the thickness of the medium. The medium includes, recorded in a principal plane at least the transparent layer with one or more information items for carrying out either tracking, focusing, synchronization or addressing or any combination. Also included in each stratum is one more guidance information items. A registration layer is formed on the outer surface of the recording medium.

EP 0461956 also assigned to Thomson CSF and entitled "*Optical information storage on superimposed layers*" discloses a system for optical storage of information. The information is stored within the volume of a transparent layer instead of being stored at the surface. Sequences of different information are stored in different strata of the layer. The means of writing and of reading are designed to focus a light beam in the plane of a specified stratum without focusing it on the others. Photodetectors permit selective detection of the beam perturbations engendered by each of the respective individual strata. The material of the transparent layer is preferably a material with photoinduced index variation.

US Patent No. 6,574,174 (Amble *et al.*) entitled "*Optical data storage system with multiple layer media*" discloses an optical information storage system using optical storage media including multiple data layers or stacks wherein each of the multiple data stacks has a storage density comparable to a conventional single layer optical disk. The optical data storage system comprises an optical medium having a single dedicated servo layer and multiple data stacks which each contain an embedded servo format, a servo laser beam positioned to maintain a first focus point on the dedicated servo reference layer, a read-write laser beam positioned to maintain a second focus point on one of the data stacks, a first, dedicated servo system which provides focus and tracking error correction according to error signals generated from the dedicated servo layer, and a

second, embedded servo system which provides focus and tracking error correction according to error signals generated from the data stacks. The dedicated servo layer, in different embodiments of the invention, may be positioned either below or above the data stacks in the optical medium, or interposed between data stacks. The data stacks may comprise discrete physical data layers or "virtual" data layers defined by a format hologram. The servo and read-write lasers may differ in wavelength and/or polarization.

WO 98/25268 (Glushko) entitled "*Fluorescent Optical Memory*" discloses a method of manufacturing a fluorescent 3-D optical memory device implementing an active medium capable of storing information at high information density, and an optical memory device manufactured by this method. To this end there are applied suitable fluorescent layers so that the medium is not monolithic.

In magnetic media, it is customary that higher level formatting of the device is performed at the end user location under the control of the computing system that uses the magnetic storage device. This gives the computing system a lot of space for optimizing the formatting according to the computing system unique requirements, one example is the ability to divide one magnetic hard disc into few partitions where one part is used by one Operating System (OS) and the other is used by another OS. The different parts are usually readable only by the appropriate OS. The formatting of the disc can be divided into different layers of format. The low level formatting of the disc is common to both OS in this example while the higher level formatting into an ordered file system is the part unique to each OS.

Formatting enables, among other things:

- an agreed upon organization of the data in the medium;
- finding and reading the logical and physical location of the basic data units (data blocks, sectors, block.clusters);
- recording data in accurately documented and retrievable locations;
- tracking the data and tuning to a defined location where the data is stored for data retrieval, tracking (see for example USSN 10/096,369 filed March 13, 2002 and entitled "*Method for tracking data in an optical storage medium*" in the name of the present assignee), inscription of Adaptive Gain Control and synchronization headers, and more;
- encompassing system information in the media e.g. disc type and model, sensitivity, density of recording, manufacturing information and Individual ID and tags;
- tuning the reading and or recording device parameters to the medium, e.g. changing laser power in DVD-R according to different media;
- encompassing file system and files at different levels of security and visibility (to the different users);

denoted by d2 is 160 micron. Fig. 3c illustrates the structure of the formatted disc by looking at the center of the disc. The distance, in the center of the disc, between the first spiral base layer of the first half of the disc and its counter rotating pair is denoted by d3. In the embodiment shown in the figure, d3 is 40 microns and the total disc thickness is 6 mm. In a preferred embodiment the base layers include test areas to validate that there is no over-writing of the base layers.

Fig. 4 shows schematically tracking and writing a new layer to a formatted disc according to a first approach. The optical unit that is modeled as a focusing lens, for the sake of explanation only, focuses two beams of different wavelengths at different depths of the disc, separated by a distance d4. The reading spot 401 tracks a spiral that is already inscribed at a certain depth in a layer whose plane is indicated by a dashed line 402, this spiral track serving as a master. At the same time, a writing spot 403 inscribes a new spiral separated by d4 from the reading spot in the vertical direction, but having the same location along the other axes as the master.

Figs. 5a and 5b are schematic representations showing a simplified 2D view of the sampled servo technique of a second formatting method. Fig. 5a illustrates the method of extracting tracking error signal from a single track. The location of the track that is allocated for data is indicated by dashed intervals and dotted intervals indicate the locations allocated for the servo marks. Servo marks, that are the marks inscribed at the formatting step, are offset to the nominal track location, so that as the reading spot passes along the nominal track a tracking signal is collected from the servo marks. The signal is proportional, linearly or non-linearly to the overlap between the read spot and the servo marks. If the reading spot is exactly centered on the nominal track location, then the overlap with the servo marks offset to the sides of the tracks is the same and the difference between the signal obtained from a sequence of servo marks is zero. If the reading spot is nominally offset to the track, then the filtered signal from a first sequence of marks will be different from the signal from the second sequence of marks, located on the other side of the track and this difference will serve as tracking error signal, indicating the direction in which the reading spot should be moved.

Fig. 5b illustrates the use of alternating servo in the simplified 2D scheme on a patch of ten tracks t1,.., t10. The direction of reading spot scan is from left to right along the page, the servo marks of the odd numbered tracks having the left indicating servo